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## SPECIFICATIONS

1. Title of Invention  
Drill

2. Scope of Patent Claims

(1) A drill having a tip blade (1) that protrudes axially on the center of a shaft and a shoulder blade (2) that protrudes axially on the perimeter thereof, wherein:  
The blade angle ( $\alpha$ ) of said tip blade (1) is within a range of 98 ~ 112 °; and,  
The blade angle ( $\beta$ ) of said shoulder blade (2) is within a range of 50 ~ 60 °.

3. Detailed Description of Invention

[Field of Industrial Use]

The present invention is related to a drill, in particular it is related to a so-called candle type drill which has a tip blade on the center of a shaft and a shoulder blade on the perimeter thereof.

[Prior Art Technology]

This type of drill is frequently used to bore holes in glass fiber reinforced materials or acrylic fiber reinforced materials, but is generally used to bore holes in aluminum. This type of aluminum drill, due to the relative pliability of the material drilled thereby, has a tip blade with a blade angle (tip angle) of approximately 90 °, and a shoulder blade with a blade angle (shoulder angle) of approximately 40 °. When this drill is used to bore holes in glass fiber reinforced materials or acrylic fiber

reinforced materials, while there is favorable concentricity, difficulties arise with respect to the strength of the blade end, and this often leads to blade chips, thereby causing dispersion in drill life, and often leading to a shorter life span.

In addition, while there are steel drills which have tip angles of approximately  $120^\circ$  and shoulder angles of approximately  $70^\circ$ , if these drills are used to bore holes in glass fiber reinforced materials and acrylic fiber reinforced materials, they lack concentricity and cause a greater cutting thrust, and as such initial bit contact is poor, and the drilled hole lacks in roundness. Moreover, since the shoulder angle is too large, the resistance at the time a pass through drill is removed from the drilled material fluctuates greatly to produce "burrs", and otherwise markedly damaging the drilled materials to produce fiber "splinters".

[Issue Addressed by Invention]

The present invention takes into consideration the technological excesses addressed above when a candle type drill is used to bore holes in glass fiber reinforced materials or acrylic fiber reinforced materials, and was created in an effort to effectively resolve these excesses. Accordingly, the objective of the present invention is to provide a drill that posts strong centricity, favorable drill bit contact, ease of use, and does not produce "burrs" upon removal, or otherwise produce "splinters" or damage the drilled material even when used to bore holes in glass fiber reinforced materials or acrylic fiber reinforced materials.

[Means Adopted in Resolution of Issue]

The drill associated with the present invention is constituted as follows in order to resolve the aforementioned technical issues, and achieve the objective thereof.

Namely, it is a drill having a tip blade that protrudes axially on the center of a shaft and a shoulder blade that protrudes axially on the perimeter thereof, wherein the blade angle of said tip blade is within a range of  $98^\circ \sim 112^\circ$ , and the blade angle of said shoulder blade is within a range of  $50^\circ \sim 60^\circ$ .

[Action and Effect of Invention]

With the drill associated with the present invention, since the tip angle is larger than that of an aluminum drill and smaller than that of a steel drill, it is capable of producing the sufficient centricity, and adequate cutting thrust and tip strength for boring holes in glass fiber reinforced materials and acrylic fiber reinforced materials, while at the same time, because the shoulder angle is larger than that of an aluminum drill yet smaller than that of a steel drill, it is capable of producing sufficient blade strength for boring holes in glass fiber reinforced materials or acrylic fiber reinforced materials, and since the fluctuation in resistance upon the removal of the drill is less than that of a steel drill, it does not produce "burrs" or "splinters", and does not otherwise damage the material that has been drilled.

[Example Embodiment]

Hereunder we will discuss one example embodiment of the present invention while referring to FIG. 1 through FIG. 6. FIG. 1 is a side elevation view of the blade tip of the drill associated with the present invention. FIG. 2 is a top elevation view of the drill of FIG. 1 as viewed in an axial direction. In these FIGS., 1 is the tip blade, 2 is the shoulder blade, 3 is the flank face of tip blade 1, 4 is the flank face of shoulder blade 2, and 5 is the chip discharge channel. The tip angle  $\alpha$  for the drill of this example embodiment is  $105^\circ$ , while the shoulder angle  $\beta$  is  $55^\circ$ .

FIG. 3 is a graph diagram illustrating the relationship between tip angle and tool life span. FIG. 4 is a graph diagram illustrating the relationship between shoulder angle and tool life span. FIG. 5 is a graph diagram illustrating the relationship

between shoulder angle and "splinter" production. FIG. 6 is a graph diagram illustrating the relationship tip angle and hole roughness. FIG. 3 and FIG. 6 each used a drill with a shoulder angle of  $55^\circ$  in their tests, while FIG. 4 and FIG. 5 each used a drill with a shoulder angle of  $105^\circ$  in their tests. The boring conditions shared in each of the tests are as follows: number of rotations: 2653 r.p.m.; feed rate: 0.04 mm / rev.; boring depth: 10 mm; drill diameter: 12 mm; material subject to boring: FRP (fiber reinforced plastic). As we can comprehensively see from each of the graph diagrams, the drill with a tip angle of between  $100^\circ \sim 110^\circ$  and a shoulder angle of between  $50^\circ \sim 60^\circ$  has the longest life span, and produced a better finish in terms of internal hole roughness and the production of "splinters".

#### 4. Brief Description of Drawings

FIG. 1 is a side elevation view of the blade tip of the drill associated with the present invention. FIG. 2 is a top elevation view of the drill of FIG. 1 as viewed in an axial direction. FIG. 3 is a graph diagram illustrating the relationship between tip angle and tool life span. FIG. 4 is a graph diagram illustrating the relationship between shoulder angle and tool life span. FIG. 5 is a graph diagram illustrating the relationship between shoulder angle and "splinter" production. FIG. 6 is a graph diagram illustrating the relationship tip angle and hole roughness.

- 1 ... Tip Blade
- 2 ... Shoulder Blade
- $\alpha$  ... Blade Angle of Tip Blade
- $\beta$  ... Blade Angle of Shoulder Blade

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FIG. 1

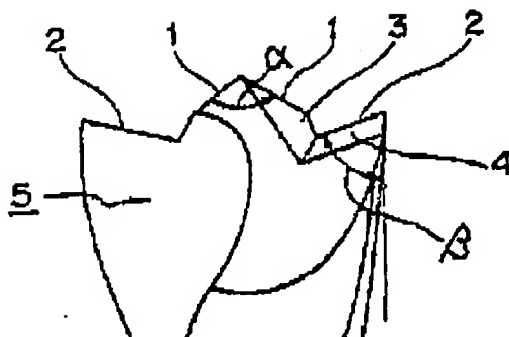


FIG. 2

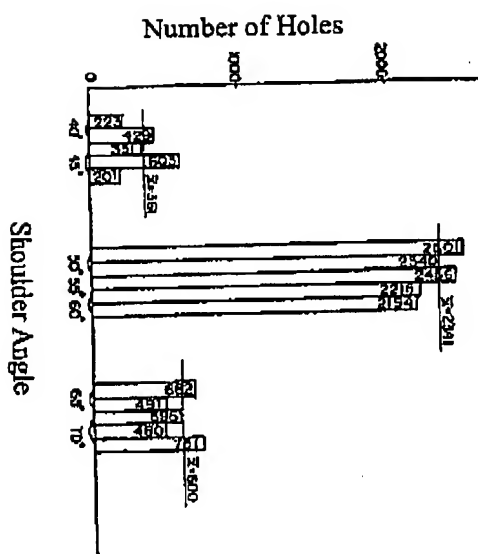
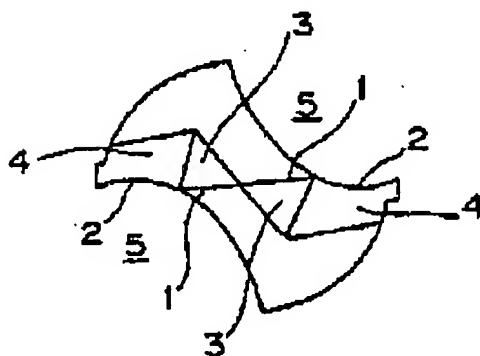


FIG. 4

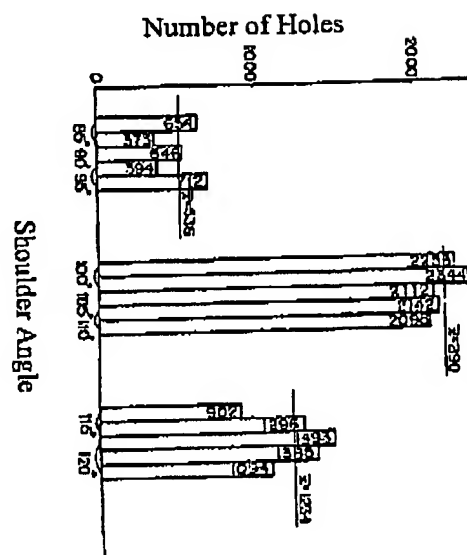


FIG. 3

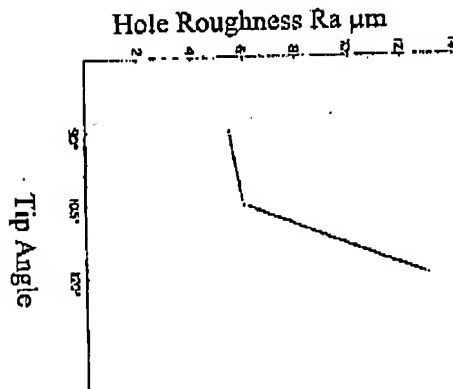


FIG. 6

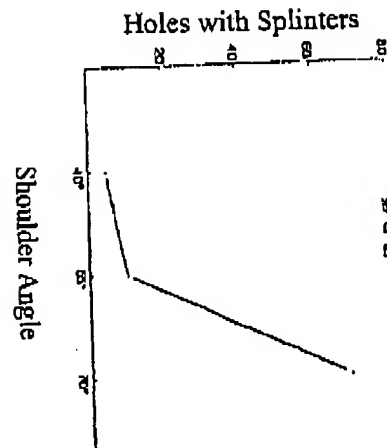


FIG. 5